GRØNLANDS GEOLOGISKE UNDERSØGELSE
BULLETIN NO. 13.

UPPER CRETACEOUS BELEMNITES FROM WEST GREENLAND

BY

TOVE BIRKELUND

WITH 1 FIGURE IN THE TEXT AND 1 PLATE

Reprinted from
Meddelelser om Grønland Bd. 137, Nr. 9

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Abstract.

A description is given of Upper Cretaceous belemnites from West Greenland, and their affinities are discussed. The genera *Actinocamax* and *Belemnoteuthis* are represented. 2 new species viz. *Actinocamax groenlandicus* and *Belemnoteuthis rosenkrantzi* are established. *A. groenlandicus* is presumably from the Coniacian and is closely allied to Upper Turonian-?Lower Senonian species. *B. rosenkrantzi* is most probably from the Senonian.

INTRODUCTION

Belemnites from the Upper Cretaceous in West Greenland have so far only been mentioned by DE LORIOL (1882, p. 206) as "*Belemnitella* or *Belemnites*" from Nûgssuaq, West Greenland. RAVN (1918 a, p. 364), however, showed that the fossil mentioned by DE LORIOL was a fish vertebra.

During the geological expeditions to the northern part of West Greenland in 1946—1954, sent out by the Geological Survey of Greenland under the leadership of Professor ALFRED ROSENKRANTZ, comprehensive collections of marine fossils were made in the Upper Cretaceous deposits of the Nûgssuaq and Svartenhuk peninsulas. Among them were a few belemnites and these are described in the present paper. The material is scanty, but it must be emphasized that belemnites are extremely rare in these deposits.

I am much indebted to Professor ROSENKRANTZ for permitting me to study this material and for the valuable support he has given me. I also thank Dr. WIENBERG RASMUSSEN for his great help and much good advice during the study.

The preparation of the material was undertaken by Mr. KR. SKOU, who also collected a great part of the specimens. The drawings for the illustrations were carried out by Miss GUNNI JØRGENSEN, and the translation into English by Miss ESTHER JACOBSEN. The manuscript has kindly been read by Professor J. B. CRAGG and Mr. M. R. HOUSE, B. A. of the University of Durham. I thank them all for the great help which they have given me.

Finally I wish to express my sincere gratitude to the Carlsberg Foundation for financial assistance.

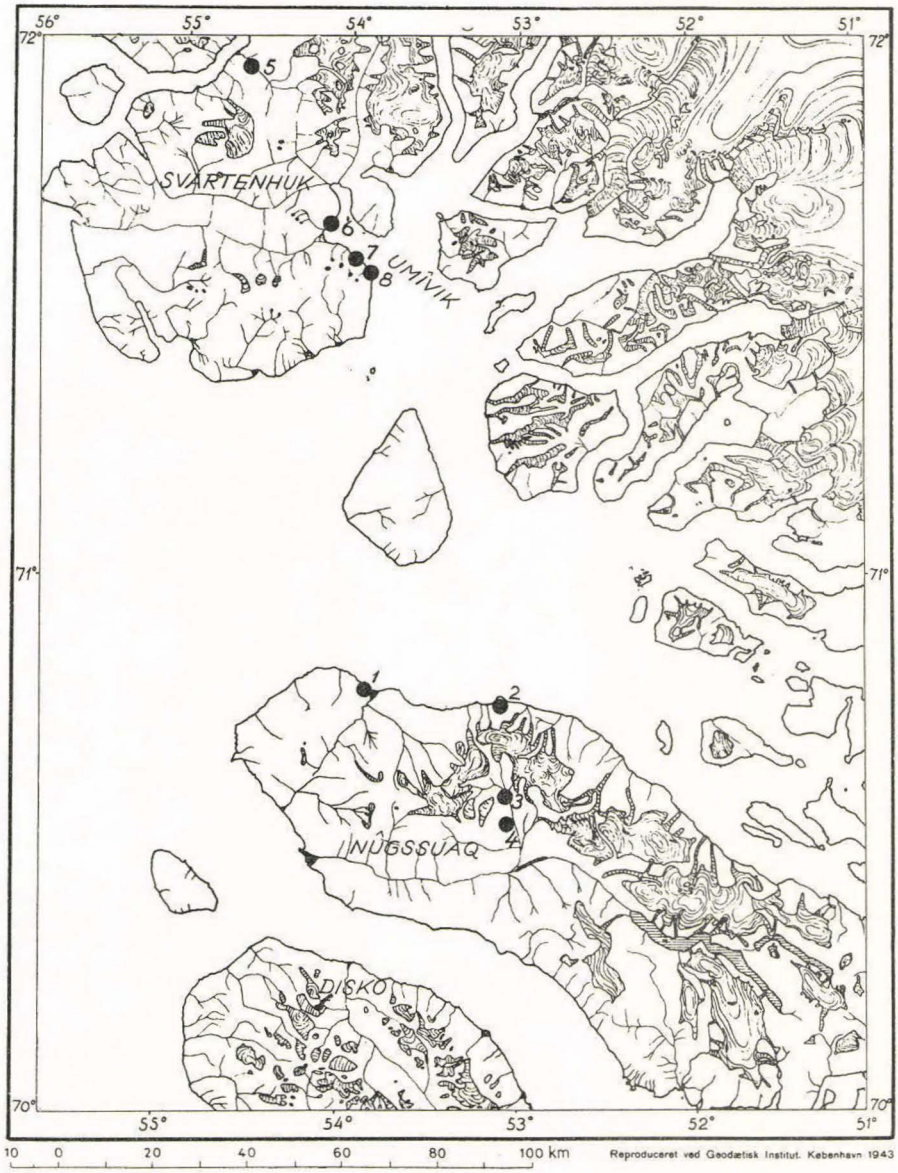

Fig. 1. Map showing the position of localities, where belemnites have been found. Loc. 1: Tuperssuartâ; loc. 2: Ikorfat; loc. 3—4: Angmârtussut; loc. 5: Simiútap kûa; loc. 6: Firefjeld; loc. 7: Tange IV kløft; loc. 8: Store Tange V kløft.

Genus **Actinocamax** MILLER, 1823.

Actinocamax groenlandicus n. sp.

Pl. 1, fig. 1 a—c, 2, 3 a—c.

Diagnosis.

Actinocamax with a slender guard. In ventral aspect slightly lanceolate; in lateral aspect the margins of the anterior part very nearly parallel, posteriorly they converge slowly. The apex acute. The ventral surface slightly flattened except in the laterally compressed alveolar region. The dorsal side slightly flattened within the hindmost third of the guard. Pseudoalveolus shallow, in cross section ovate. The ventral fissure long. The dorso-lateral grooves faintly developed. Parts of the surface of the guard granulated, most pronounced ventrally, and slightly longitudinally striated.

Material.

Four fragments, all of them found in a large lenticular concretion at Tuperssuartâ, Nûgssuaq, West Greenland (fig. 1, loc. no. 1).

1) Guard lacking the alveolar region, pl. 1, fig. 1 a—c (holotype).
2) Anterior part of the guard lacking, as in fragment no. 1, pl. 1, fig. 2.
3) The central part of the guard with the posterior part of the ventral fissure preserved. The alveolar region and apical region lacking.
4) Alveolar end, pl. 1, fig. 3 a—c.

The specimens are in the collections of the Mineralogical and Geological Museum, Copenhagen.

Professor A. ROSENKRANTZ gives the following information about locality and age:

"The belemnites have been found within a series of bituminous shales containing concretionary layers and concretions filled with shells of a species of *Inoceramus* which appears to be closely related to *I. lundbreckensis* MC. LEARN, 1929. *Baculites* are also of frequent occurrence. The fauna is as a whole very rich in specimens, but comprises only few species. At a somewhat higher level a few *Scaphites*, mostly fragmentary, have been collected belonging to the *ventricosus* group and closely

related to *Scaphites ventricosus saxitonianus* MC. LEARN, 1929. Accordingly the age of the belemnites is presumably Coniacian".

Dimensions.

Fragment no. 1 has a length of 58.8 mm and represents an individual of an estimated length of 80 mm. In ventral aspect the diameter is 9.0 mm in front, increasing posteriorly to 9.5 mm at a point a little before the middle of the fragment, from where the sides converge with slightly increasing rapidity backwards. In lateral aspect the maximum diameter of 9.5 mm is situated at the front end of the fragment, posteriorly the margins converge slowly.

Fragment no. 2 is somewhat stouter than fragment no. 1. It has a length of 57.8 mm. In ventral view the diameter is 10.2 mm in front increasing posteriorly to 11.0 mm at a point a little before the middle of the fragment. In lateral view the maximum diameter of 11.1 mm is situated at the front end of the fragment, posteriorly the margins converge slowly.

Fragment no. 3 has a length of 52.0 mm. In ventral aspect it has a diameter of 8.2 mm at the hindmost part of the ventral fissure, increasing posteriorly to 9.3 mm a little behind the middle of the fragment. In lateral aspect the maximum diameter of 9.1 mm is situated at the front end of the fragment, backwards the margins converge slowly.

Fragment no. 4 is 21.4 mm long. In ventral view it has a diameter of 8.5 mm at the anterior part of the pseudo-alveolus, increasing slowly backwards. Laterally the diameter is 9.4 mm at the front end, increasing very slightly backwards.

Description.

The guard is slender. In ventral aspect it is slightly lanceolate. The maximum diameter is situated behind the middle of the length of the guard, from where it decreases in breadth very slowly anteriorly. Posteriorly it decreases in breadth, first rather slowly, then somewhat more rapidly. In lateral aspect it is slightly cone-shaped, except in the anterior part the margins of which are almost parallel. The guard is flattened ventrally, except in the alveolar region where it is laterally compressed; also dorsally it is slightly flattened, though only within the hindmost third. Thus, the guard is in cross section ovate anteriorly with a maximum diameter in a dorso-ventral direction, subcircular in the middle part, while elipsoid posteriorly with its maximum diameter in a lateral direction.

The pseudoalveolus is seen in fragment no. 4 (pl. 1, fig. 3 c). In cross section it is ovate; its depth is 4.5 to 5.0 mm. The anterior part of the surface of the pseudoalveolus is flattened and forms an obtuse angle

with the posterior part which has a more abrupt position. The length of the ventral fissure is 12 mm; its bottom is concave and curves backwards to the ventral side. The distance between the protoconch and the beginning of the bottom of the ventral fissure at the ventral wall of the pseudoalveolus (Schatsky index) is apparently very small.

The dorso-lateral grooves appear as two shallow depressions extending only to a little behind the middle of the guard. The type specimen (pl. 1, fig. 1 a—c) and fragment no. 3 show lateral grooves. They are visible up to 1 cm behind the posterior end of the ventral fissure and are converging ventrally.

The surface of fragments no. 1 (pl. 1, fig. 1 a—c) and no. 2 (pl. 1, fig. 2) is covered with a rather elaborate ornamentation consisting of granulae and longitudinal striae. The small, low, well-separated granulae are on both specimens close-set on the anterior part of the ventral side; a few scattered granulae can be distinguished in the middle part of the dorsal side (pl. 1, fig. 1 a), while it is apparent that they are completely lacking in an area on both sides of the median dorsal part. The hindmost part of both guards seems to be quite without granulation. On the anterior part of the ventral side and the lateral sides of fragment no. 1 (pl. 1, fig. 1 b—c) longitudinal striae can be distinguished consisting of very small, well-separated grooves. No. 2 (pl. 1, fig. 2) shows a similar striation, and in this case it is still better preserved and can be observed on almost the whole ventral side, besides it can also be distinguished on the dorsal side, and very slightly on the anterior part of the lateral sides.

On account of the sparse material it has not been possible to investigate the ontogenetic development of the species.

Affinity with other species.

Actinocamax groenlandicus is distinguished particularly by its long ventral fissure and granulated surface; furthermore it is distinguished by its shallow pseudoalveolus and slender shape.

The species *A. quadratus* (DE BLAINVILLE), 1827, comprises forms with a ventral fissure of a similar length as is seen in the Greenland species. Furthermore this species and the closely related *A. granulatus* (DE BLAINVILLE), 1827, have developed a characteristic granulation. The granulation differs, however, from that of *A. groenlandicus* in covering bigger parts of the surface of the guard than is the case in the above-mentioned forms, and in the granulae forming corrugated transverse lines. Moreover these forms differ in shape and cross section of the guard, in the presence of distinct vascular impressions, and with regard to the specimens which have a ventral fissure of the same length as that of *A. groenlandicus*, in a considerably more depressed pseudoalveolus.

A. mammilatus (NILSSON), 1827, may have a ventral fissure of a length similar to that of *A. groenlandicus*, and a pseudoalveolus of a similar depth. However, *A. mammilatus* is without granulation, and adult specimens differ much from *A. groenlandicus* on account of their robust shape, their pronounced ventral flattening, and their markedly triangular pseudoalveolus. Young individuals differ less because of their slender shape, but can be distinguished from *A. groenlandicus* by their more pronounced ventral flattening and lack of granulation.

The fragments of some belemnites from Kangerdlugssuaq, East Greenland, have been described by SWINNERTON (1943, p. 406) under the name of *A.* cf. *blackmorei* CRICK, 1907. *A.* cf. *blackmorei* has a long ventral fissure like that of the West Greenland species, but otherwise differs from this by its much larger size, its fusiform shape in ventral as well as in lateral view, by its marked ventral flattening, its slightly conical pseudoalveolus, and its total lack of granulation.

A. verus MILLER, 1823 may show an ornamentation consisting of corrugated transverse lines of granulae. Apart from the presence of granulae *A. verus* shows no likeness to the Greenland form, either as regards shape, ventral fissure, or pseudoalveolus.

Another form with granulation, *A. depressus ornata* (MOBERG), 1885, p. 56, pl. 5, fig. 26 is known. Except for the presence of granulation it is, according to STOLLEY (1897, p. 291), in full agreement with the typical *A. depressus* ANDREAE, 1896 (? = *A. grossouvrei* JANET, 1890) both as regards morphology and stratigraphic occurrence. It is easy to distinguish from *A. groenlandicus* by the shape similar to that characteristic of *A. mammilatus*, the distinct ventral flattening, the triangular cross section of the pseudoalveolus, and the somewhat shorter ventral fissure.

All the above-mentioned Senonian species of *Actinocamax* show resemblance to the Greenland form as to one or more of the following characters: length of ventral fissure, depth of pseudoalveolus, and the presence of granulation. All species mentioned differ from *A. groenlandicus* in the form of the guard.

Besides the species mentioned in the preceding pages, there are in Upper Turonian — Lower Senonian species of *Actinocamax*, all comparatively rare, which like the above show a certain likeness to *A. groenlandicus* with regard to the ventral fissure, the pseudoalveolus, and granulation, but which in contradistinction to these also show considerable likeness to *A. groenlandicus* in the shape of the guard.

This applies to *A. bohemicus* STOLLEY, 1916, *A. paderbornensis* SCHLÜTER, 1894, *A. strehlensis* (FRITSCH), 1872, *A.* sp. aff. *strehlensis* (FRITSCH), and *A. manitobensis* (WHITEAVES) *lawrenci* JELETZKY, 1950. The former three species are known from Upper Turonian European deposits, while the latter two lived in the Colorado Sea, an area to which

the fauna containing *A. groenlandicus* has affinities. According to JELETZKY (1950) these two species can be referred to Upper Turonian — ?Lower Senonian.

From the Turonian—Lower Senonian deposits in Europe comes moreover *A. lundgreni* STOLLEY, 1897, which, like *A. groenlandicus*, has a shallow pseudoalveolus; but apart from this it differs so much from the Greenland form that it will not be further dealt with.

A. bohemicus STOLLEY, 1916 (figured by FRITSCH, 1872, pl. 16, fig. 17) and *A. groenlandicus* are of somewhat the same size and slenderness. An especially striking likeness can be observed between *A. bohemicus* and the type specimen (fragment no. 1, plate 1, fig. 1 a—c) except for the apical end which is more acute in *A. bohemicus* than in the type specimen, and while the maximum diameter of *A. bohemicus*, in ventral view, is in the anterior part from where it decreases evenly backwards, the maximum diameter of *A. groenlandicus* is in ventral view behind the middle. While the pseudoalveolus of *A. groenlandicus* is depressed, that of *A. bohemicus* forms a low cone. Nor are the cross sections of the pseudoalveoli exactly alike, as that of *A. bohemicus* is more markedly subtriangular than that of *A. groenlandicus*. The diameter of the anterior part of *A. bohemicus* is of the same size in dorso-ventral as in lateral view, but that of *A. groenlandicus* is greatest in dorso-ventral direction. While the ventral fissure of *A. groenlandicus* is 12 mm long, that of *A. bohemicus* is only 6—7 mm. According to the description by FRITSCH (1872, p. 18), *A. bohemicus* is without dorso-lateral grooves; to judge from the cross section of the pseudoalveolus (FRITSCH, 1872, pl. 16, fig. 17 b), it must be assumed that there have been rather slight indications as is the case with *A. groenlandicus*. A careful description of the ornamentation of the surface of *A. bohemicus* is given by FRITSCH (1872, p. 19). Both in *A. bohemicus* and in *A. groenlandicus* granulae are most crowded on the ventral side, while the dorsal side is smooth or show scattered granulae. Whether the ornamentation is the same in the very anterior part of the surface of the guard cannot be decided, as this part of the surface is poorly preserved. The ornamentation of *A. groenlandicus* differs in forming no transverse lines and in lacking granulae on the surface of the posterior part of the guard. The feeble longitudinal striae are in *A. bohemicus* only present round the ventral fissure, but are lacking in the other parts of the surface.

Among the differences mentioned between *A. bohemicus* and *A. groenlandicus* those of the depth of the pseudoalveoli and the length of ventral fissures seem to be of the greater taxonomic importance.

Another granulated form described from Upper Turonian is *A. paderbornensis* SCHLÜTER, 1894. This specimen is established on a single fragment and has not been figured. It differs from *A. bohemicus* i. a. in

its much greater size and the lack of a ventral fissure. This form is so insufficiently known that it will not be mentioned further.

As to the characteristics of its alveolar end, *A. groenlandicus* is closer allied to the type of *A. strehlensis* (FRITSCH, 1872, pl. 16, fig. 10) than to *A. bohemicus*, and with regard to the development of the ventral fissure it is closer allied to *A.* sp. aff. *strehlensis* (mentioned by JELETZKY, 1950). Regarding other characters *A. groenlandicus* differs from these two species principally in being granulated; otherwise it differs from the type of *A. strehlensis* in being slenderer and less lanceolate and in having a longer ventral fissure. From *A.* sp. aff. *strehlensis* it differs in being smaller and having a depressed pseudoalveolus. Besides, the dorso-lateral grooves of *A.* sp. aff. *strehlensis* can be traced far behind the middle of the guard.

A. manitobensis lawrenci JELETZKY, 1950 is similar to the Greenland species in having a rather slender guard and a depressed pseudoalveolus of a similar cross section. Especially the ontogenetically younger stages of *A. manitobensis lawrenci* show considerable likeness to *A.* sp. aff. *strehlensis* in the shape of the guard (JELETZKY, 1950, fig. 1) and thus also to the Greenland species. *A. manitobensis lawrenci* differs mainly from *A. groenlandicus* in its greater size, its far shorter ventral fissure, its dorso-lateral grooves which can be traced almost as far as the apex, and its lack of granulation.

From the above it appears that *A. groenlandicus* is closer allied to the Upper Turonian — ?Lower Senonian species, *A. bohemicus*, *A. strehlensis*, *A.* sp. aff. *strehlensis*, and *A. manitobensis lawrenci*, than to the younger forms, and thus it may be regarded as the successor of one of these.

Now, our knowledge of the relation between these species is but poor, and a fuller collection may well show them to be identical. GEINITZ' figures of *A. strehlensis* (GEINITZ, 1872—75, Part 2, pl. 31, fig. 13—14) suggest such possibilities seeing that these specimens agree with *A. bohemicus* in the shape of the guard and in the structure of the pseudoalveolus while they are without granulation as *A. strehlensis*. Other early species of *Actinocamax* are extremely variable in the shape of the guard and the structure of the pseudoalveolus, characters which are more constant in the later species of *Actinocamax*.

In studying the phylogenetic relations of *A.* sp. aff. *strehlensis*, JELETZKY (1950) considers the ontogenetic development and possibly also the Schatsky index to be of great taxonomic value. Unfortunately these characters of *A. strehlensis* and *A. bohemicus* are unknown. The ontogenesis is unknown in *A. groenlandicus* too. JELETZKY (1950, p. 15) considers with STOLLEY (1916, p. 100—101) that the granulation of the surface is of great phylogenetic value. He states (1950, p. 15):

"*Actinocamax bohemicus* STOLLEY, 1916 is even more like *A.* sp. aff. *strelensis* in the form of the guard, character of its alveolar end, and the development of the alveolar furrow. Yet both forms cannot be united, for *A. bohemicus* is pronouncedly granulated, and thus belongs to another phylogenetical branch of the genus *Actinocamax* (STOLLEY, 1916, p. 100—101)".

STOLLEY (1916, p. 102) assumes a phylogenetical relationship between *A. bohemicus* and *A. verus*, which is likely on account of the granulation forming corrugated transverse lines on the surface of both species.

The granulation within the group of *A. westphalicus*, *A. granulatus*, and *A. quadratus* indicates the considerable value of this special character. But a granulated form within *A. depressus* (? = *A. grossouvrei*), namely the previously mentioned *A. depressus ornata* (MOBERG), indicates that this character may well vary within a full species. It must be taken into account that such variation may be present in the *A. strehlensis-bohemicus* group on account of the great likeness which can be observed in other essential characters.

All evidence seems to justify the specific independence of *A. groenlandicus* from other described species of *Actinocamax*, and on account of its diverging stratigraphical occurrence in relation to the forms closest related to it from Upper Turonian it is referred to a new species.

Occurrence: Senonian, Coniacian, Nûgssuaq, West Greenland.

Actinocamax aff. **groenlandicus** n. sp.

Pl. 1, fig. 4 a—d.

Material.

One complete guard from the north coast of Nûgssuaq (Ikorfat, Scaphites hor., 600 m above sea-level, fig. 1, loc. no. 2).

The specimen is in the collections of the Mineralogical and Geological Museum, Copenhagen.

Stratigraphy.

The geological age of the specimen here described cannot be fixed with absolute certainty. It has been collected in a conglomerate together with fossils of Upper Campanian age, but under such conditions that the presence of outworked older Cretaceous fossils cannot be excluded.

If this *Actinocamax* specimen were really derived from Upper Campanian or younger deposits, it would be the youngest representative of the above genus, which otherwise becomes extinct at the end of Lower Campanian. However, the morphology of the specimen, especially the structure of the pseudoalveolus, suggests no such stratigraphically young

individual, as in appearance it is closer to Upper Turonian and Lower Senonian *Actinocamax* species than to the later species of this genus.

Description.

Length of the guard 68.8 mm; in ventral aspect slightly lanceolate, the diameter in front 8.9 mm, increasing gently and evenly posteriorly to 10.5 mm a little behind the middle of the guard; from this place the sides converge with increasing rapidity backwards. In lateral aspect, within the anterior fourth of the guard, the diameter is constant (9.9—10.0 mm); then the margins converge—first slightly, then more rapidly towards apex. The ventral side of the guard is moderately flattened in its entire length; laterally the anterior part of the guard is slightly compressed; dorsally the guard seems flattened within the posterior part, but it may be due to deformation of this area.

In cross section the pseudoalveolus is ovate. Its shape is like a very low cone with a small, narrow hole for the protoconch at its top. Round the margin is a slightly projecting ridge. Length of the ventral fissure is about 3 mm; the course of the bottom is faintly concave. The distance between the protoconch and the bottom of the ventral fissure where it joins the pseudoalveolus (Schatsky index) is 0.5 mm.

The dorso-lateral grooves are but feebly developed, but are visible almost as far as apex. The lateral grooves cannot be distinguished.

At a limited area of the middle part of the ventral surface a distinct ornamentation is preserved consisting of small, low granulae, well separated from each other (pl. 1, fig. 4b). This ornamentation may originally have been more extensive.

Affinity with other species.

The specimen is apparently closest allied to *A. bohemicus* STOLLEY, 1916, and *A. groenlandicus* n. sp. But it also shows affinity with *A. westphalicus* (SCHLÜTER), 1874, as to some characters.

A. bohemicus (FRITSCH, 1872, pl. 16, fig. 17) has, in common with the just described specimen, a low conical pseudoalveolus, a short ventral fissure, and a granulated surface, but it has a slenderer form, a more distinctly triangular cross section of the pseudoalveolus, and furthermore the granulae of this species form the pattern of corrugated transverse lines.

While typical specimens of *A. westphalicus* can very easily be distinguished from the above-mentioned guard, showing differences in the shape of the guard and in the structure of the pseudoalveolus, specimens of an extreme development may have a certain likeness to it as to the characters mentioned. Besides, *A. westphalicus* may be granulated and sometimes obtain a length similar to that of the Greenland specimen,

but in such cases it is stouter. As the Greenland individual does not exhibit any of the characteristics of the typical *A. westphalicus* specimens, neither the shape of the guard nor the structure of the pseudoalveolus, nor the rather distinct vascular impressions, a closer affinity seems unlikely.

It must be assumed that the specimen is closest related to *A. groenlandicus*. It shows likeness to that species in the shape of the guard, the greater degree of slenderness of *A. groenlandicus* being the only distinction. The character of the granulation is the same in the two forms, it is only impossible to decide whether the extension is quite the same, seeing that the granulation is only preserved within a small area on the ventral side in the specimen described. Also the course of the bottom of the ventral fissure of the two forms exhibits great likeness to each other. The specimen differs mainly from *A. groenlandicus* in having a cone-shaped pseudoalveolus, a shorter ventral fissure, and in the fact that the dorso-lateral grooves can be traced at a longer distance posteriorly. The age of the specimen as compared with *A. groenlandicus* is unknown. The structure of the pseudoalveolus suggests that it is stratigraphically older than *A. groenlandicus*.

As to the morphological similarity of the specimen to *A. bohemicus* no definite statement is yet possible. A more abundant material of both forms is required for the solution of this problem.

Occurrence: Upper Cretaceous, Nûgssuaq, West Greenland.

Actinocamax cf. **primus** Arkhangelsky, 1912.

Pl. 1, fig. 5.

Material.

Guard with phragmocone from Simiútap kûa, Svartenhuk, West Greenland (fig. 1, loc. no. 5). Guard much exfoliated from weathering and impossible to detach from the enclosing matrix.

The specimen is in the collections of the Mineralogical and Geological Museum, Copenhagen.

Age: The specimen is derived from shales with impressions of plants, the age of which has not been determined.

Description.

The guard is 52 mm long and very slender. The specimen is so poorly preserved that it cannot be orientated with certainty, and only the side exposed can be described. In this view the diameter is constant (5 mm) within the anterior half of the guard; from this point the margins converge evenly backwards and produce a very acute apex. The position

of the phragmocone, with the top of the cone immediately below the upper edge of the guard, shows that the pseudoalveolus has not been essentially depressed. Neither the ventral fissure, the dorso-lateral grooves, the lateral grooves, nor any sort of ornamentation of the surface are discernible.

The phragmocone is but poorly preserved. The angle of the cone is about 20°. The transverse septa are very badly preserved with the exception of four, which are situated near the middle of the phragmocone. The distance between them, from the posterior to the anterior one, is 0.8, 1.0, and 1.3 mm respectively.

Affinity with other genera.

The shape of the guard cannot be distinguished from certain representatives of *A. primus* ARKHANGELSKY, for instance the figure of *A. primus elongata* JELETZKY (ARKHANGELSKY nom. nud.) by JELETZKY (1948 b, p. 340, fig. 2). Thus it has in common with this species the very slender shape and subcylindrical outline. Also the pseudoalveolus of *A. primus* show in some cases similarity to that of the specimen mentioned here (ARKHANGELSKY, 1912, pl. 10, fig. 4, 5). *A. primus* is recorded from Middle Cenomanian and the lower part of Upper Cenomanian.

The guard just described cannot with certainty be determined specifically on account of the poor preservation. The exact age of the deposits in question is not known within the period of Upper Cretaceous, but the existence of this genus suggests the age of Cenomanian — Lower Campanian.

Occurrence: Upper Cretaceous, Svartenhuk, West Greenland.

Actinocamax sp.

Pl. 1, fig. 6, 7, 8.

Material.

Three specimens from Umîvik, Svartenhuk, West Greenland.

1) Tange IV kløft (fig. 1, loc. no. 7). The specimen was collected loose 5 m above sea-level. It consists of a rather well-preserved guard which it has not been possible to free completely from the enclosing matrix (pl. 1, fig. 8).

2) Store Tange V kløft (fig. 1, loc. no. 8) 40 m above sea-level. Fragment consisting of the posterior part of the guard (pl. 1, fig. 6).

3) The east side of Firefjeld (fig. 1, loc. no. 6). The specimen was collected loose. Only the posterior part of the guard is preserved (pl. 1, fig. 7).

The specimens are in the collections of the Mineralogical and Geological Museum, Copenhagen.

Age: According to information given by Professor ALFRED ROSENKRANTZ, the specimens are derived from Senonian deposits containing a *Scaphites ventricosus* fauna from Coniacian.

Description.

The only complete guard (specimen 1, pl. 1, fig. 8) is 60 mm long and, as specimens 2 and 3, very slender. The entire guard is half-way embedded in the rock. Neither the ventral fissure, the dorso-lateral grooves, nor the lateral grooves can be distinguished with certainty, for which reason it is difficult to orientate the guard. It is, however, possible to discern a feeble edge on the guard running along the centre line of the exposed part. To the right of this feebly developed edge the guard is flattened, and this area must be assumed to represent part of the ventral side, while the area to the left forms the one lateral side. In this view the guard is lanceolate, the maximum diameter of 6.2 mm is situated behind the middle of the length of the guard; from this place the margins converge evenly anteriorly. Backwards the margins converge with increasing rapidity and produce a moderately acute apex. In ventral aspect specimen no. 2 (pl. 1, fig. 6) is lanceolate, its maximum diameter is 5.9 mm and situated 21 mm in front of the apex. The dorsal side of the fragment is weathered.

Specimen no. 3 (pl. 1, fig. 7) is very poorly preserved and cannot be orientated. It is slightly lanceolate, its maximum diameter is about 6 mm and situated 20 mm in front of the apex.

The ventral side of specimen no. 2 seems, as is the case in specimen no. 1, to be flattened; specimen no. 3 is so poorly preserved that this character is undiscernible.

The pseudoalveolus of specimen no. 1 (pl. 1, fig. 8) is partly eroded, partly concealed with matrix, and consequently we have but little knowledge of its character.

In specimen no. 2 one dorso-lateral groove is slightly discernible; it is extending to a point situated 1 cm from the apex. The specimens do not exhibit any kind of ornamentation on the surface.

The specimens mentioned, which belong to the same zone and area, are so much like each other in size and form that they must be assumed to belong to the same species.

Affinity with other species.

From Coniacian the following species are known: *A. westphalicus* (SCHLÜTER), 1874, *A. verus* MILLER, 1823, and *A. groenlandicus* n. sp. Furthermore *A. lundgreni* STOLLEY, 1897, which was established on

Upper Turonian specimens from Denmark (RAVN, 1918 b, 1946), has often been mentioned from the Lower Senonian deposits (for instance RIEDEL, 1930, JELETZKY, 1948 a). (In a planned publication on Danish Upper Cretaceous belemnites the author intends to give an account of the stratigraphical occurrence of *A. lundgreni*).

None of the species mentioned above seem to have special affinity with the specimens from Svartenhuk. The one showing greatest likeness as to the slender form is *A. groenlandicus*, but that species is considerably larger than the three specimens in question, and besides it is granulated.

As the other fossils found together with these specimens of *Actinocamax* show affinities with the fauna of the Niobrara formation (ROSENKRANTZ, 1942 a), there is the possibility that the specimens are identical with the forms that have lived in the Colorado sea described by JELETZKY (1950).

From the Assiniboine member of the Favel formation, Manitoba, the following species have been found: *A. manitobensis* (WHITEAVES), 1889 with three subspecies, *A.* sp. aff. *strehlensis* (FRITSCH), 1872, and *A.* sp. aff. *plenus* (BLAINVILLE), 1825. These deposits are by JELETZKY (1950) referred to Upper Turonian. But he is of opinion that on account of the likeness between *A. manitobensis lawrenci* JELETZKY, 1950 and *A. lundgreni* some Coniacian beds may also be represented.

JELETZKY (1950, p. 21) mentions guards from Montana and Iowa which seem to be closely related to *A. verus*, a guard which apparently is specifically identical with *A. manitobensis trehernensis* JELETZKY, 1950, some specimens very poorly preserved, mainly juvenile specimens which JELETZKY tentatively refers to *A.* sp. cf. *manitobensis*, and besides a guard which shows great likeness to *A. plenus*. These belemnites are by JELETZKY considered as belonging to at least two horizons of different age, ranging from Turonian to Santonian.

Among the above-mentioned specimens those from Greenland have a likeness to the juvenile specimens of *A. manitobensis* which are very slender as compared with full-grown individuals. However, they differ from these in being more pronouncedly lanceolate, and since only small slender forms have been found at the Greenland localities, it must be assumed that these are full-grown individuals.

Further material is necessary for a specifical determination.

Occurrence: Senonian, Coniacian, Svartenhuk, West Greenland.

Genus **Belemnoteuthis** PEARCE, 1842.

Diagnosis.

Shell consisting of a much reduced guard, a pro-ostracum, and a conical phragmocone. Guard built up of radiating prisms of calcite. Traces of concentrically arranged growth-layers are only known in one species. Its anterior part covers the phragmocone as a thin investment which decreases in thickness onwardly. Medio-dorsally a shallow furrow can be observed, and on each side of this a ridge in the posterior part. The ridges are faintly diverging anteriorly. Medio-ventrally it may sometimes be provided with a small list bounded by two faint furrows.

Belemnoteuthis rosenkrantzi n. sp.

Pl. 1, fig. 9 a—g.

Diagnosis.

A *Belemnoteuthis* of small size. Length from the apex of the guard to the protoconch about one seventh the length of the phragmocone. The dorsal ridges of the guard diverge slightly, but they gradually flatten out in the anterior third of the phragmocone. The ventral surface of the guard smooth with no list developed. The angle of the cone about 15°. The protoconch rather large. The length of the chambers in relation to their maximum diameter decreases from 0.47 posteriorly to 0.37 anteriorly. The external layer of the conotheca shows lines of growth, the course of which indicates that the dorsal region of the pro-ostracum between the asymtotes has been extremely narrow.

Material.

One specimen consisting of guard, phragmocone, and the posterior part of pro-ostracum, from the valley Agatdalen (Angmârtussut), Nûgssuaq, West Greenland (fig. 1, loc. no. 3).

This specimen is the holotype of the species.

The specimen is in the collections of the Mineralogical and Geological Museum, Copenhagen.

From the same locality several fragments of phragmocones are known, they are described on page 23. Investigations of further material may show that they can all be referred to the same species.

Professor A. ROSENKRANTZ gives the following information of locality and age:

"The *Belemnoteuthis* has been found in bituminous concretions occurring as pebbles in a conglomerate with bituminous shale as matrix. The pebbles contain a large number of Senonian fossils belonging to several levels. The shales hold a Danian fauna with i. a. *Thyasira conradi*

ROSENKRANTZ, 1942 b and *Gryphæa* cf. *vesicularis* LAMARCK. In the pebbles enclosing the *Belemnoteuthis* only indeterminable fish scales have been found, but seeing that the pebbles must be older than the Danian, and only Senonian levels are represented within the pebbles of the conglomerate, the age of the Belemnoteuthis is most likely Senonian."

Description.

The type specimen is rather small, the total length of the guard and phragmocone is 27.9 mm.

The guard is split longitudinally, and only one half is preserved (pl. 1, fig. 9 a). It is embedded in the enclosing matrix, and as it has not been possible to remove this material without damaging the fragment, only the fractured surface and shape can be described. This has a longitudinal section that is nearly at right angles to the dorso-ventral plane. The length from apex to the protoconch is 3.8 mm. The diameter of the guard at the protoconch is 1.7 mm. The guard is cone-shaped. The margins converge evenly backwards to the immediate vicinity of the apical end from where they converge somewhat more rapidly. The fractured surface shows distinctly the structure of the guard, which is built up of radiating prisms of calcite. Also the apical line stands out distinctly. It is eccentrically situated, the distance to the surface of the guard at the protoconch is thus 1.1 mm to one side, and 0.6 mm to the other. The eccentricity is most likely primary seeing that the guard is not weathered in this area. The fractured surface shows no concentrically arranged growth-layers. The guard covers the phragmocone as an investment that becomes thinner anteriorly. A small portion of this thin covering is preserved on the surface of the conotheca (pl. 1, fig. 9 a, d). Its surface is covered with a slightly rough longitudinal striation and a striation, irregular as well, but with an oblique concentrical course. Apart from this, other portions of this thin investment are preserved, but it has not been possible to isolate them from the enclosing matrix, and for this reason only the inner side can be investigated. On the anterior dorsal part of the inner side of the guard (pl. 1, fig. 9 c) a flat, slightly raised area is visible medio-dorsally which must be presumed to correspond to a shallow furrow on the surface. Its breadth at the suture between the two anterior chambers of the phragmocone is 0.5 mm, the breadth decreases faintly backwards. On the inner side of the guard there are, in the apical end on both sides of the dorsal furrow, elongated areas which stand out light against the surrounding dark parts; within these areas the guard appears to be thicker and seems to correspond to flat ridges on the surface. They are distinctly visible in the area along the posterior two thirds of the phragmocone. They diverge slightly and increase in breadth anteriorly to 0.4 mm, then they flatten out, and

finally they disappear at the anterior third of the phragmocone. The ventral side of the guard can be observed both from the inner side and in cross section. The medio-ventral part shows no traces of any kind of list.

In dorsal view (pl. 1, fig. 9 a) the phragmocone is regularly conical. The angle of the cone is 15°. In lateral view (pl. 1, fig. 9 b) the phragmocone also appears to be almost regular. The section is, as shown in pl. 1, fig. 9 c, subcircular with a faint dorso-ventral flattening. The phragmocone consists of 17 chambers, the protoconch included. The length of the spheroid protoconch is 1.5 mm, its maximum diameter, measured from lateral side to lateral side, is 1.2 mm. The distance between the transverse septa increases evenly anteriorly. The length of the chambers in relation to their maximum diameter decreases from 0.47 posteriorly to 0.37 anteriorly (see table 1). The transverse septa show, as compared with the longitudinal course of the phragmocone, a faintly oblique tendency being more caudally situated ventrally than dorsally (pl. 1, fig. 9 b). Furthermore, a narrow marked ventral lobe has developed on the suture-lines (pl. 1, fig. 9 f). The siphuncle is situated peripherally at the ventral margin (pl. 1, fig. 9 e).

The very hindmost part of the pro-ostracum is preserved, and furthermore the outer layer of the conotheca shows the presence of distinct growth-lines which give quite a good impression of the shape of the pro-ostracum (pl. 1, fig. 9 a, g).

The growth lines curve sharply forward dorsally, becoming hyperbolic to the longitudinal axis of the phragmocone in the asymtotic zones, which form the boundary areas to the dorsal region of the pro-ostracum (Naef, 1922, p. 211, fig. 73). This dorsal region is only 0.6 mm wide in the hindmost part of pro-ostracum, and its margins being only slightly diverging, it must also have been unusually narrow in the anterior part of the pro-ostracum.

The length of the pro-ostracum is difficult to estimate, as it is impossible to locate the crossings of the growth-lines in the dorsal region. On the inner side of the guard the growth-lines of the conotheca are present as impressions (pl. 1, fig. 9 c). In the dorsal region, immediately within the asymtotes, is a narrow, rounded list on each side. The intervening area is almost plane and slightly depressed. Along the middle of the dorsal region is a faintly rounded list (pl. 1, fig. 9 g). This plane, slightly depressed area seems to correspond to a similar one which, as previously mentioned, appears on the guard and is limited in a similar way. This area can also be traced on the phragmocone, which exhibits two feebly developed furrows, the distance between them being the same as the breadth of the area (pl. 1, fig. 9 a). On the posterior part of the conotheca (at 3rd, 4th and 5th chamber) is a slightly depressed groove

laterally to the asymtotes. This groove may be the trace of the outer limit of one of the two ridges on the guard previously mentioned.

Table I. *Belemnoteuthis rosenkrantzi* (pl. 1, fig. 9).

Chamber No.	Length	Greatest breadth laterally	Length/ breadth laterally	Greatest breadth dorso-ventrally	Length/ breadth dorso-ventrally
17	2.5	6.8	0.37	6.7	0.37
16	2.3	6.2	0.37	6.0	0.38
15	2.1	5.5	0.38	5.3	0.39
14	2.0	5.1	0.39	4.8	0.42
13	1.9	4.5	0.42	4.4	0.43
12	1.7	4.0	0.43	..	..
11	1.5	3.5	0.43	..	..
10	2.3	3.2	?	..	..
9		?	?	..	..
8	1.2	2.8	0.43	..	..
7	1.1	2.5	0.44	..	..
6	1.0	2.2	0.45	..	..
5	0.9	2.0	0.45	..	..
4	0.8	1.7	0.47	..	..
3	0.7	1.5	0.47	..	..
2	0.6	1.3	0.46	..	..
1 (Protoconch)	1.5	1.2	..	..	..

All measures given in mm.

Affinity with other species.

The species here described under the genus *Belemnoteuthis* show close agreement with this genus as regards most of the structural features. Referred to this genus is *Belemnoteuthis antiqua* PEARCE, 1847 (type of the genus), *Belemnoteuthis restans* OWEN, 18?, and *Belemnoteuthis polonica* MAKOWSKI, 1952, all of them from Callovian; *Belemnoteuthis syriaca* ROGER, 1944 from Cenomanian, and formerly also a Triassic form, *Belemnoteuthis* sp., LANGENHAN, 1907. The latter is provided with a guard which differs much from the *Belemnoteuthis* genus, and cannot be referred to this genus (RÜGER, 1942). In *Belemnoteuthis syriaca* impressions of the soft parts and the hooks of the arms are known, but only very little is known of the structure of the shell, however no specifical identity with the Greenland form can be mentioned owing to the considerable difference in size and age. *Belemnoteuthis restans* OWEN (? NICHOLSON and LYDEKKER, 1889, p. 879, fig. 810) cited in Fossilium Catalogus, is problematic and so little known that it is impossible to make comparisons between it and the Greenland speci-

men. In *Belemnoteuthis antiqua* the structure of the guard is fairly well known. The guard of *B. rosenkrantzi* is in agreement with the guard of *B. antiqua* in the pronounced small size as compared with the phragmocone and in the development of diverging ridges in the hindmost dorsal part of the guard; the ridges are, however, feebler developed in the former than in the latter species. According to MANTELL, 1848, pl. 29, fig. 7, showing the dorsal side of *B. antiqua* (MANTELL orientates in his description the shell opposite to the usual procedure) this species seems to lack the medio-dorsal shallow furrow developed in the entire length of the guard of *B. rosenkrantzi*; besides this species has, in contrast to *B. rosenkrantzi*, a list along the middle of the ventral side (MANTELL, 1848, pl. 29, fig. 7 a). *Belemnoteuthis* sp. from Germany (of the same age as *B. antiqua*), figured by ZITTEL (1915, fig. 1268), is of a similar appearance as *B. rosenkrantzi*, but ventrally a list is developed as in *B. antiqua*. The angle of the cone is considerably smaller in *B. rosenkrantzi* (15°) than in *B. antiqua* (abt. 20°), besides the distance between the transverse septa is relatively greater in the former than in the latter case. Finally there is the difference between the phragmocone of *B. rosenkrantzi* and that of *B. antiqua* that the sutures in the former species form a narrow, marked ventral lobe, which is not the case in the latter. The morphological features of *Belemnoteuthis polonica* are fairly well known. The species differs from *B. rosenkrantzi* i. a. in the greater size, the distinct concentrically arranged growth-layers of the guard, the lack of the apical line, the greater angle of the cone, the relatively smaller distance between the transverse septa, the absence of a spheroid protoconch and lack of the ventral lobe on the suture-lines. Until the description of *B. polonica* by MAKOWSKI (1952), we have only had little knowledge of pro-ostracum of the genus *Belemnoteuthis*; it has even been maintained that this was lacking (ZITTEL, 1915). NAEF (1922, p. 277) is of a different opinion and refers to a figure by FISCHER (1887, fig. 143 a) showing the growth-lines on the conotheca. FISCHER's figure is so primitive that the course of the growth-lines gives no evidence of the shape of pro-ostracum, as it is uncertain whether the part of the growth-lines sketched represents the dorsal region only or the dorsal region and the asymtotic part. In the former case the pro-ostracum becomes very wide, in the latter very narrow as in *B. rosenkrantzi*. In *Belemnoteuthis polonica* the growth-lines of the conotheca are well preserved, the pro-ostracum may have been wide as the asymtotes are rather diverging.

From the comparison made between the representatives of the genus *Belemnoteuthis* known so far and the Greenland specimen, it appears that the structure agrees in the main; the most important taxonomic difference in the structure of the Greenland specimen is the development of a small marked ventral lobe on the suture-lines of the

phragmocone. If further material should lead to the establishment of a new genus, this would in any case be very close to *Belemnoteuthis*. This late representative of the genus *Belemnoteuthis* seems to show no special affinity with the Tertiary genera.

TRAUB (1938, p. 104, pl. 8, fig. 20 a—c) describes, however, a phragmocone from Paleocene, which is tentatively referred to the genus *Beloptera*, and which may be related to the *Belemnoteuthis* described here. The phragmocone resembles that of *Belemnoteuthis rosenkrantzi* as to size, the presence of a ventral lobe on the sutures, and the presence of a line along the dorsal side of the phragmocone. The shape of the phragmocone is, on the contrary, rather different. The guard is so badly preserved that its form is not quite distinct.

Within the genus *Diplopelus* NAEF, 1927 (*Diploconus* ZITTEL, 1868) from Tithonian, which is usually considered belonging to the same family as the genus *Belemnoteuthis*, *D. belemnitoides* (ZITTEL), according to NAEF (1922, fig. 65 i), has a pro-ostracum similar to that of *B. rosenkrantzi*, but the guard is of a different structure.

The genus *Chondroteuthis* BODE, 1933 from Upper Lias which is also closely allied to the genus *Belemnoteuthis*, has likewise a very narrow pro-ostracum, the guard is reduced as in the genus *Belemnoteuthis* but is without the furrows and ridges characteristic of this genus.

Some specimens referred to *Acanthoteuthis*, a provisional generic name for belemnites whose guard is not known with certainty (cf. NAEF, 1922, p. 178) are by some authors considered belonging to the genus *Belemnoteuthis*.

The only *Acanthoteuthis* species whose pro-ostracum is thoroughly known is *A. speciosa* MÜNSTER, 1837, whose pro-ostracum (NAEF, 1922, fig. 63 f) has a dorsal region which is much wider than that of *Belemnoteuthis rosenkrantzi*.

W. WETZEL (1930, p. 92) has established a genus and species, *Naefia neogaeia*, on the basis of 2 poorly preserved phragmocones from Senonian deposits in Peru. They are mentioned on page 25 in connection with the fragments of phragmocones from Greenland. The phragmocones of *Naefia neogaeia* appear to be of about the same age as *B. rosenkrantzi*, but their relation to this species cannot be determined on the basis of the poorly preserved material devoid of the guard and with no traces of the conotheca.

Occurrence: ? Senonian, Nûgssuaq, West Greenland.

Belemnoteuthis? sp.

Pl. 1, fig. 10 a—d, 11, 12 a—b, 13 a—b.

Material.

Six fragmentary phragmocones from Nûgssuaq, West Greenland. The valley Agatdalen (Angmârtussut), fig. 1, loc. no. 4, 2 specimens; loc. no. 3, 4 specimens.

The specimens are in the collections of the Mineralogical and Geological Museum, Copenhagen.

Age: The phragmocones here described were collected in concretions at the same locality as *Belemnoteuthis rosenkrantzi* and besides at another locality in the valley Agatdalen with similar conglomeratic deposits. Presumably they are of Senonian age as *B. rosenkrantzi* (cf. p. 17).

Description.

The phragmocones bear resemblance to each other, and may possibly be referred to the same species. 4 of them are rather well preserved, and the description will mainly be based on these 4 specimens.

In dorsal view they seem to have the appearance of a regular cone. The angle of the cone is, in dorsal view, in specimen 1 about 24°, in specimen 3 about 20°. In lateral view the phragmocones are slightly curved towards the ventral side. The cross section of the chambers is subcircular with a very faint ventral flattening (pl. 1, fig. 10 d). The transverse septa are, compared with the longitudinal axis of the phragmocones, faintly oblique, the transverse septa being situated more caudally ventrally than dorsally. The suture-lines in specimen no. 3 (pl. 1, fig. 12 a) form ventrally a rather marked lobe, in specimen no. 1 (pl. 1, fig. 10 b) such a ventral lobe is absent. In specimens 2 and 4 the ventral side of the phragmocones cannot be observed.

The only protoconch is somewhat smaller than that of *B. rosenkrantzi*; the length is 1.1 mm, the maximum diameter 1.1 mm. The transverse septa are situated closer to each other than in *B. rosenkrantzi*; the distance between them increases gently onwards. The relation of the length to the maximum breadth of the chambers is shown in tables 2, 3, and 4. Thus it is for specimen 1: 0.26—0.28, for specimen 2: 0.21—0.22, and for specimen 3: 0.21. The siphuncle is, as it appears on pl. 1, fig. 10 d, situated peripherally at the ventral margin.

The specimens in which the dorsal side of the phragmocone is exposed (specimen 1, pl. 1, fig. 10 a, and specimen 4, pl. 1, fig. 13 a—b), display medio-dorsally a rounded list bounded by two feebly developed furrows on each side. The list decreases slightly in breadth caudally.

In the cases where the conotheca is preserved (in specimen 1 as impression, and in specimen 3) the presence of growth-lines can be

Table II. *Belemnoteuthis*? sp. specimen 1.

Chamber no.	Length	Greatest breadth laterally	Length/ breadth laterally	Greatest breadth dorso-ventrally	Length/ breadth dorso-ventrally
7 (the foremost)	1.4	..	..	..	..
6	1.3	5.0	0.26	..	..
5	1.2	4.4	0.27	4.5	0.27
4	1.1	4.1	0.27	4.1	0.27
3	1.0	3.7	0.27	3.7	0.27
2	0.9	3.2	0.28	3.3	0.27
1	?	2.8	..	3.0	..

Table III. *Belemnoteuthis*? sp. specimen 2.

Chamber no.	Length	Greatest breadth dorso-ventrally	Length/ breadth dorso-ventrally
4 (the foremost)	1.1	..	..
3	1.0	..	..
2	1.0	4.5	0.22
1	0.9	4.3	0.21

Table IV. *Belemnoteuthis*? sp. specimen 3.

Chamber no.	Length	Greatest breadth laterally	Length/ breadth laterally
2 (the foremost)	1.7	..	..
1	1.5	7.1	0.21
	..	6.6	..

All measures given in mm.

observed on the outmost layer; from these (pl. 1, fig. 12 b) it appears that the distance between the asymtotic zones is quite small, and so there is reason to assume that the dorsal region of the pro-ostracum is narrow as in *Belemnoteuthis rosenkrantzi*.

Two of the phragmocones (nos. 3 and 4) exhibit dorsally a tube-like development between the guard and the phragmocone, apparently built up of the various layers of the conotheca (pl. 1, fig. 12 b, 13 b). To all

appearance such a canal has not previously been observed in the *Belemnoidea*, nor could it be demonstrated in *B. rosenkrantzi*, though the latter has a dorsal furrow in the conotheca.

Fragment no. 4 is provided with a very thin fibrous covering at the anterior part of the protoconch; there is reason to suppose that this is a fragment of the guard. Apart from this we have no knowledge of the appearance and size of the guard of these forms.

Affinity with other species.

The phragmocones differ from the phragmocone of the type for *B. rosenkrantzi* as regards the angle of the cone, the size of which is more than 20° in the former, and only 15° in the latter, and as regards the ratio of length to breadth of the chambers, which is considerably less in the former than in the latter. The tube-like dorsal development in the conotheca of the two phragmocones seems to be absent in *B. rosenkrantzi.*

The phragmocones are in agreement with that of *B. rosenkrantzi* as regards the development of the medio-dorsal furrows, though somewhat more distinct than in *B. rosenkrantzi.*

There is also agreement with regard to the oblique course of the transverse septa as compared with the longitudinal axis, and one of the specimens is provided with a similar ventral lobe. Furthermore, the growth-lines of the conotheca suggest that the shape of pro-ostracum has been the same in both forms.

W. WETZEL (1930, p. 92) has described two small, poorly preserved phragmocones from Peru (Quiriquina beds) of Senonian age under a new genus and species, *Naefia neogaeia.* These phragmocones show agreement with the Greenland specimens in being of similar size and having a similar cross section. Furthermore, the course of the transverse septa seems to be oblique as compared with the longitudinal axis of the phragmocone (WETZEL, 1930, pl. 14, fig. 3 (to the left)). No ventral lobe seems to be present in *Naefia neogaeia*, and the angle of the cone is less than 15°.

The phragmocones mentioned may be closely allied to the Greenland ones, but seeing that only the characters mentioned above are visible and described, and the conotheca completely unknown, it is impossible to decide further as to these fragments.

Further material of *B. rosenkrantzi* might contribute to the solution that the loose phragmocones found in the same beds as *B. rosenkrantzi* belong to this genus and species, the variation of this as well as other species of the genus being unknown. The agreeing growth-lines on the conotheca of the two forms support this opinion. On the other hand, it

seems difficult to explain the difference in structure of the dorsal area of the conotheca of the two forms.

Occurrence: ? Senonian, Nûgssuaq, West Greenland.

Paleogeography.

From northern localities the genus *Actinocamax* was formerly known from East Greenland (SWINNERTON, 1943; DONOVAN, 1954) and from the arctic coast of Siberia (RYABUKIN, 1940, cited by JELETZKY, 1950). The West Greenland specimens correspond with JELETZKY's theory of a northern route of migration from Europe to America for this genus. The number of *Actinocamax* specimens seems always to have been very small at localities within the northernmost part of the area of distribution of the genus and at the interior plains of North America as compared with the European localities.

Belemnoteuthis rosenkrantzi shows only affinities with European species.

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Plate 1.

Fig. 1: *Actinocamax groenlandicus* n. sp. Holotype. Specimen no. 1. × 1. Coniacian. Loc. no. 1, Nûgssuaq.
- 1 a: Dorsal view.
- 1 b: Ventral view.
- 1 c: Lateral view.

Fig. 2: *Actinocamax groenlandicus* n. sp. Ventral view. Specimen no. 2. × 1. Coniacian. Loc. no. 1, Nûgssuaq.

Fig. 3: *Actinocamax groenlandicus* n. sp. Specimen no. 4. × 1. Coniacian. Loc. no. 1, Nûgssuaq.
- 3 a: Ventral view.
- 3 b: Lateral view.
- 3 c: Lateral view; the specimen split longitudinally showing the bottom of the ventral fissure.

Fig. 4: *Actinocamax* aff. *groenlandicus* n. sp. × 1. Upper Cretaceous. Loc. no. 2, Nûgssuaq.
- 4 a: Dorsal view.
- 4 b: Ventral view.
- 4 c: Lateral view; the anterior part is split longitudinally, showing the bottom of the ventral fissure.
- 4 d: View of the anterior end.

Fig. 5: *Actinocamax* cf. *primus* ARKHANGELSKY; guard and phragmocone. × 1. Upper Cretaceous. Loc. no. 5, Svartenhuk.

Fig. 6: *Actinocamax* sp. Ventral view of specimen no. 2. × 1. Coniacian. Loc. no. 8, Svartenhuk.

Fig. 7: *Actinocamax* sp. Specimen no. 3. × 1. Coniacian. Loc. no. 6, Svartenhuk.

Fig. 8: *Actinocamax* sp. ?Lateral view of specimen no. 1. × 1. Coniacian. Loc. no. 7, Svartenhuk.

Fig. 9: *Belemnoteuthis rosenkrantzi* n. sp. Holotype. ? Senonian. Loc. no. 3, Nûgssuaq.
- 9 a: Dorsal view, showing the longitudinally split guard, the phragmocone, the posterior part of the pro-ostracum, and the conotheca with growth-lines preserved. On the surface of the conotheca at g, part of the guard is preserved. At p the conotheca is not preserved, and thus the phragmocone is exposed; at this place can be seen grooves medio-dorsally on the phragmocone. × 2.
- 9 b: Lateral view. × 2.
- 9 c: The inner side of the anterior dorsal part of the guard showing the medio-dorsal furrow and the two diverging ridges and impressions of the growth-lines of the conotheca. × 2.

9 d: The part of the guard visible in Fig. 9 a at g. ×10.

9 e: The anterior transverse septa of chamber no. 13, the siphuncle visible. ×2.

9 f: The anterior part of the phragmocone and conotheca in ventral view. The growth-lines of the conotheca and the ventral lobe of the suture-lines visible. ×2.

9 g: The posterior part of the pro-ostracum, the anterior part of the phragmocone, and conotheca in dorsal view. The asymtotic zones (a) and the dorsal region (d) of the pro-ostracum and conotheca visible. ×4.

Fig. 10: *Belemnoteuthis*? sp. Specimen no. 1. ×2. ? Senonian. Loc. no. 3, Nûgssuaq.

10 a: The phragmocone in dorsal view. The grooves along the middle of the dorsal side visible.

10 b: The phragmocone in ventral view; parts of the conotheca preserved.

10 c: The phragmocone in lateral view.

10 d: The anterior transverse septa of chamber no. 4. The siphuncle visible.

Fig. 11: *Belemnoteuthis*? sp. in lateral view, showing a polished longitudinal section; the siphuncle visible. Specimen no. 2. ×2. ? Senonian. Loc. no. 4, Nûgssuaq.

Fig. 12: *Belemnoteuthis*? sp. Specimen no. 3. ×2. ? Senonian. Loc. no. 3, Nûgssuaq.

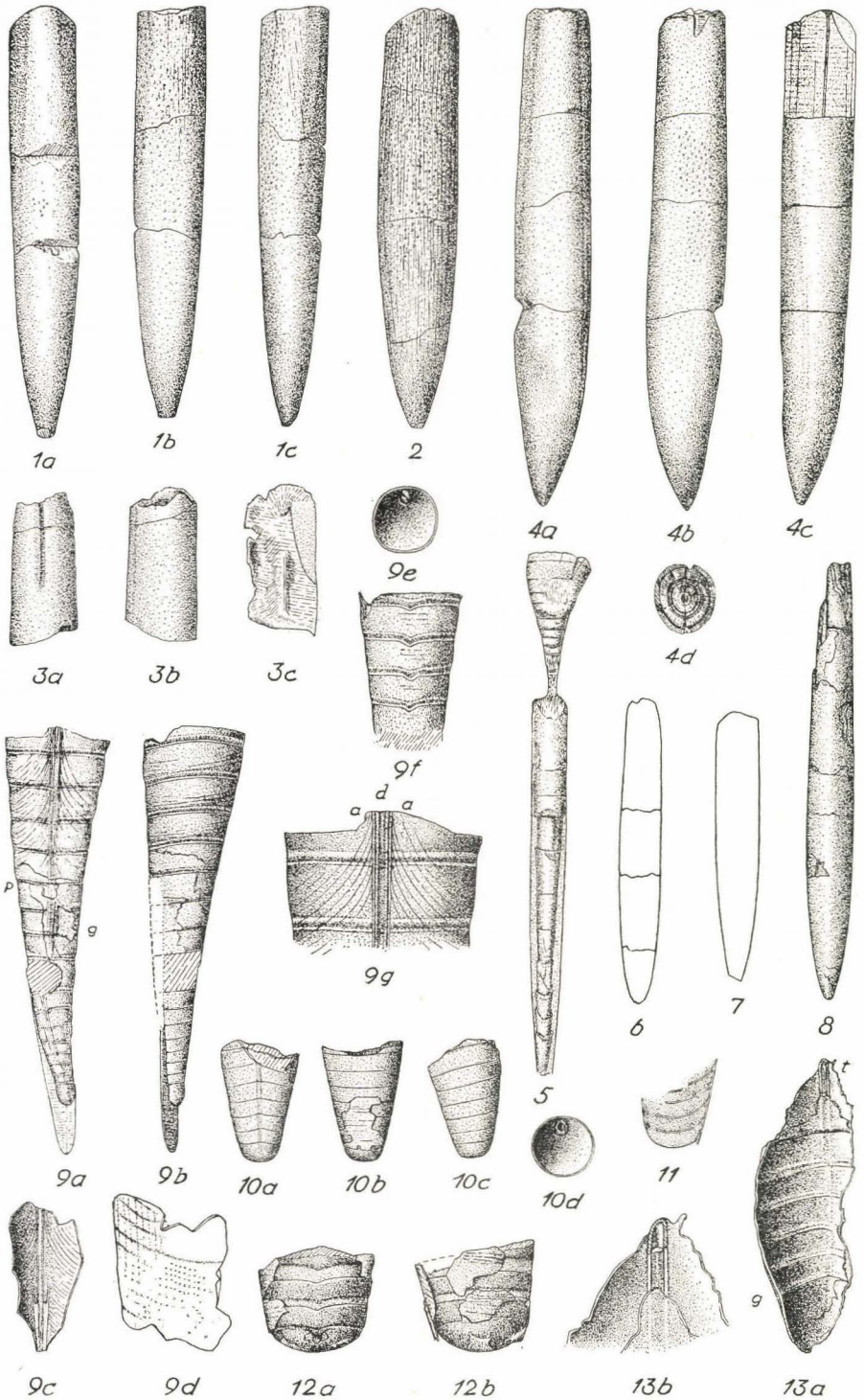
12 a: The phragmocone in ventral view. Parts of the conotheca with growth-lines preserved. The ventral lobe of the suture-lines visible.

12 b: The phragmocone in lateral view. Parts of the conotheca with growth-lines preserved. The dorsal tube-like development is visible.

Fig. 13: *Belemnoteuthis*? sp. Specimen no. 4. ? Senonian. Loc. no. 3, Nûgssuaq.

13 a: Fragment showing the innerside of the hindmost, dorsal part of the phragmocone and the conotheca. At g part of the guard is preserved. At t the tube-like development is visible. ×10.

13 b: The anterior part with the visible part of the tube-like development. ×20.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